LLNL Environmental Restoration Division (ERD)
Standard Operating Procedure (SOP)

ERD SOP 1.14: Final Well Development/Specific Capacity Tests at LLNL Livermore Site—Revision: 1

AUTHOR(S):
J. Karachewski*

APPROVALS:	Date
Albert J Samuelson **Division Leader**	5/22/01
Linda Lee Berry **Livermore Site Assistant Project Leader**	5/22/01

CONCURRENCE:	Date
Valerie Dibley **QA Implementation Coordinator**	5/22/01

*Weiss Associates

1.0 PURPOSE

The purpose of this SOP is to document field activities for final well development and specific capacity tests. This task is performed after the drill rig has completed its initial development and a pump has been installed in a newly completed well. This task involves overpumping and intermittent pumping of the well in order to clear residual drilling mud and remaining fines (silt and clay) from the sand pack and well. In addition, data is obtained for estimating the specific capacity, maximum flow rate, and optimum flow rate for subsequent hydraulic testing. This final well development takes place prior to hydraulic testing and the collection of the routine ground water sample.

2.0 APPLICABILITY

The purpose of final well development and specific capacity tests is to obtain representative samples of turbid-free ground water, collect accurate water-level data, and determine maximum and optimum flow rates. These factors will ensure:

1. Selection of a dedicated pump appropriate for the hydraulic characteristics of a well.
2. The dedicated pump is not damaged by fine-grained sediments during subsequent sampling or hydraulic testing.

3.0 REFERENCES

3.1 Gass, Tyler E., "Monitor Well Development," *Water Well J.*, January 1986, pp. 52–55.

3.2 Barcelona, M. J., Gibb, J. P., Helfrich, J. A., and Garske, E. E., *Practical Guide to Ground Water Sampling*, U.S. Government Printing Office, EPA 600/2-85-104, 1985.

3.3 Driscoll, F. G., Groundwater and Wells, Second Edition, Johnson Division, St. Paul, MN, 1089 pp, 1986.

4.0 DEFINITIONS

See SOP Glossary.

5.0 RESPONSIBILITIES

5.1 Division Leader (DL)

The DL's responsibility is to ensure that all activities performed by ERD at the Livermore Site and Site 300 are performed safely, comply with all pertinent regulations and procedures, and provide the necessary equipment and resources to accomplish the tasks described in this procedure.

5.2 Hydrogeology Group Leader (HGL)

The HGL's responsibility is to ensure that proper procedures are followed for activities (i.e., drilling, borehole logging and sampling, monitor well installations and development) and to oversee the disposal of all investigation derived wastes.

5.3 Field Personnel

The field personnel's responsibilities are to properly develop wells to obtain the highest yield and the highest quality ground water samples in compliance with all established operational and safety procedures, and to inform the HGL when the procedures are inappropriate. Field personnel are also responsible for (1) communicating the performance of development activities to the Hydrogeologist (HG) and recommending modifications of field methods to improve well yield, and (2) notifying the sampling coordinator that final well development is completed.

5.4 Sampling Coordinator (SC)

Once well development is complete and the SC is notified, the SC will add the well to the Routine Ground Water Sampling Schedule. The technical information required for purging wells is also provided by the SC in the Well Specification Table.

5.5 Site Safety Officer (SSO)

The SSO is responsible for ensuring the safety of ERD's ongoing operations, field work, and facilities. The SSO's responsibility is to review the potential hazards and procedures for all field activities. The SSO directs this information to the LLNL Hazards Control Department to determine if a new Operational Safety Procedure (OSP) is required, thus assuring that existing documentation addresses all ES&H issues for each operation.

5.6 Subproject Leader (SL)

The SL is responsible for the overall investigation, planning, assessment, and remediation within an area.

5.7 Technical Release Representative (TRR)

The TRR is responsible for the acquisition and administration of blanket contract releases for the procurement of goods and services. The TRR has the authority to obligate LLNL for payment of goods and services, delegated by the LLNL Business Manager through the LLNL Procurement Department.

5.8 Hydrogeologist (HG)

The HG is responsible for helping the SL determine borehole/well locations and design, hydrostratigraphic analysis, and planning/evaluation of hydraulic tests.

6.0 PROCEDURES

6.1 Preparation

6.1.1 Prior to commencement of field activities, perform preparation activities per SOP 4.1, "General Instructions for Field Personnel" and review the equipment checklist (Attachment A). The field personnel should check with the HG to obtain information on well design and estimated flow rate in order to determine the appropriate number of portable tankers. The DC coordinates with field personnel for the use of portable tankers and associated equipment.

6.1.2 Review the suite of ground water samples to be collected after final well development is complete with the HG.

6.2 Procedures

6.2.1 Wells with Electric Submersible Pumps

A. Connect a discharge line from pump to flow meter on portable storage tank.

B. Plug extension cord with Ground-Fault Interrupter (GFI) from generator into well control box. The extension cord's on/off switch box should be "off."

C. Obtain depth-to-water (DTW) measurement. Record corresponding time.

D. Turn on generator, followed by pump. Record time (t) on the well development field sheet (Attachment B) and baseline sampling data sheet (Attachment C).

E. Measure flow rate (Q) with a 5-gal bucket and with totalizing flow meter on tanker by timing 10 gal of influent flow.

F. Note color, odor, amount, and type of sediment (e.g., clay, silt, sand) in the water. Note changes in these parameters as pumping proceeds.

G. Obtain Q and DTW measurements every 5–10 min for the first 30 min.

H. After 30 min record DTW. Determine "specific capacity" = $Q/\Delta s$ at t = 30, where Q = flow rate and Δs = (DTW at t = 30) minus (DTW at t = 0).

I. Shut off pump, note and record time, and allow the water level to recover. Periodically, record DTW and times as recovery is occurring. The frequency of measurements will depend on the rate of water level recovery in the well. For wells with flow rates greater than 1 gpm, measure the depth to water every couple of minutes for the first 15 minutes and then every 10 minutes thereafter until the water level recovers to approximately 90% of the original reading. For wells with flow rates less than 1 gpm, measure the depth to water every five minutes for the first half hour and then every two hours.

J. Estimate optimum Q for a subsequent 1-hr drawdown test, i.e., the Q that will maximize drawdown, but not daylight a pressure transducer after 60 minutes of continuous pumping.

Note: It is more desirable to pump at a lower Q and obtain a steady-state pumping level in 45–60 min, than to have the water level continue to draw down after 45–60 min. The former procedure produces a better data curve when the drawdown test data points are plotted.

K. Pump well intermittently for at least 2 hr. Maximize drawdown but do not daylight pump intake.

Example:

Pump on—30 min

Pump off—5 min

Pump on—15 min

Pump off—5 min, etc.

The suggested periods for a high-yielding well (high flow rates) are listed in the above example. For low-yielding wells, shorten the pumping period from 30 to 10 minutes, allow water levels to recover, and attempt to remove at least 3 casing volumes of water. If the well is pumped dry, allow the water levels to recover overnight, before repeating these steps. The purpose is to surge the well and overpump it to remove fine sediment and stabilize the well's sand pack.

Note: Always record the time and DTW when the pump is turned on or off.

L. Final development is complete when:

1. Water is clear and free of sediment.

2. For a high-yielding well, calculate Δs for three or more flow rates. In contrast, for a low-yielding well calculate Δs for two flow rates, if possible.

M. Collect ground water sample per SOP 2.6, "Sampling for Volatile Organic Compounds."

6.2.2 Wells with Bladder Pumps

A. Connect bladder pump air line to the Well Wizard controller pump supply line. Connect Well Wizard air compressor supply line to Well Wizard controller air pressure inlet. All necessary hoses are stored in Well Wizard controller case.

B. Place discharge line in portable tanker.

C. Record DTW and time.

D. Start pump by starting the Well Wizard's air compressor. Record time (t).

E. Measure and record flow rate (Q) with a 5-gal bucket.

F. Note the color, odor, type, and amount of sediment in water. Record any changes in these parameters as pumping proceeds.

G. Record Q and DTW measurements as often as practical.

H. At t = 30 (30 min. after "pump on") record DTW. Determine "specific capacity" (see Section 6.2.1, Step H).

Note: Because flow is not constant, specific capacity is not as accurate but can be useful.

I. Pump well intermittently for at least 2 hr until water is clear. Continue recording Q and DTW.

Note: Because most wells with bladder pumps have a sustainable yield <1 gpm, a slug test may be necessary to determine hydraulic properties (see SOP 3.3 regarding slug tests).

J. Collect ground water samples per SOP 2.6.

6.2.3 Important Information Recorded After Final Well Development

- Specific capacity.
- Total pumping time (i.e., excluding recovery periods).
- Total gallons pumped.
- Optimum sustainable Q for drawdown tests.
- Maximum Q.
- Water clarity, odor, flow rate, etc.

Important: When final well development is completed, inform SC and provide them with an optimum Q for sampling.

6.3 Post Operation

6.3.1. Perform post operation activities as described in SOP 4.1, "General Instructions for Field Personnel."

6.3.2. Decontaminate all equipment per SOP 4.5, "General Equipment Decontamination."

6.3.3. Prior to disposal, store containers of water produced during development in a secure area until water is treated.

6.3.4 After review, give the original field forms to the HG and copies to the SC.

7.0 QUALITY ASSURANCE RECORDS

7.1 Final Well Development Field Sheet

7.2 LLNL Ground Water Sampling Data Sheet

8.0 ATTACHMENTS

Attachment A—Equipment Checklist

Attachment B—Final Well Development Field Sheet

Attachment C—LLNL Baseline Sampling Data Sheet

Attachment A

Equipment Checklist

Equipment Checklist

All wells:

____ Water-level probe/engineer's tape graduated in hundreths of a ft
____ 5-gal bucket
____ Watch with stopwatch capabilities
____ Calculator, clipboard, pencil
____ Well development forms

Wells with electric submersible pumps:

____ 230-volt generator
____ Black extension cord with GFI and on/off switch box. Note: different generators require extension cords—make sure the cord and generator are compatible
____ Pump control box (must match voltage and horsepower of pump)
____ PVC fittings (elbows, unions, etc.)
____ Hoses
____ Tool box (with wrenches, hose fittings, Teflon tape)

Wells with bladder (Well Wizard) pumps:

____ Well Wizard control box with air compressor

Attachment B

Final Well Development Field Sheet

Environmental Restoration Division

FINAL WELL DEVELOPMENT FIELD SHEET

Site	❑ Livermore Site ❑ Site 300	Page of	By: Billy Clark
Well ID		Location/Area	
Date			
Development Method(s): Multiple pumping/over pumping events with variable rate.			
Screened Interval (ft bgs):		Well Diameter (in):	
Depth to Water Before Development (ft bmp):		Sounded Depth (ft bmp):	
Development Equipment (AMS, Pump, Bail):		Pump Intake Depth (ft bmp):	

Clock Time	Depth to Water (ft)	Gallons Pumped	Flow Rate (gpm)	Comments (method, pump on/off, water clarity, odor, sounded depth)

Well Development Summary						
Total Number of Pumping Events and Rates:						
Specific Capacity (Q/Δh) for each Event:						
Total Pumping Time (min):	Total Volume Extracted (gals):					
Total Volume of Water Injected (gals):						
Estimated Sustainable Yield (gpm):						
Qualitative Description of Well Yield (Poor <1 gpm, Fair 1-5 gpm, Good 5-15 gpm, High >15 gpm):						

bgs - below ground surface
bmp - below measurement point

Attachment B. Final Well Development Field Sheet.

Attachment C

LLNL Baseline Sampling Data Sheet

LLNL Baseline Sampling Data **2001**

Monitor Well: _____ Well ID: _____

Date: _____ Extraction Well: _____

CoC #: _____

Purging Device: *AMS/ ES / RF / BP / PB / OTHER

Dedicated / Portable

Casing Diameter/gal./ft

2"	3.5"	4.5"	5"	6"	8"
.163	.5	.826	1.02	1.47	2.61

Depth of Casing: _____ P.O.M = _____

Depth to Water: _____ S.I.: _____ Casing Volume (gal.): _____

Water Column (ft) _____ Intake: _____ Initial Flow Rate (gpm): _____

Time Pump On: _____ Measured by: graduated cylinder /flow meter/other

Time Pump Off: _____ Treatment Facility: _____

Min.	Time	GPM	Gal.	Volumes	pH	Temp C	SC	OG	Depth to Water
	Well Sustains: gpm								

Meter	Serial #	Calibrated
pH		yes/no
S.C.		yes/no
H_2O		yes/no
Other		

Project:	Livermore Site - LGIV
Analytical Lab (1)	
Analytical Lab (2)	
Samplers Initials/Employer:	

Sample ID.: _____ Time: _____

QC Sample ID: _____ Time: _____

Requested Analyses

VOCs, Metals, Etc.	Rad
O E602/ __ x 40 ml VOAs/0 preservatives (pres.)	O E906/ 4 x 40 ml glass/0 pres.
O E624/ __ x 40 mL VOAs/0 pres.	O E900/2 x 1 L plastic
O GENMIN/2 x 1 L, plastic	O E903+904/2 x 1 L plastic
O NPDESMETALS/1 x 1 L plastic	O E913.0/ __ x 250 ml glass
O E218.4B/1 x 500 ml, plastic	O AS:UISO/ __ x 1 L plastic
O Other: _____	O Other: _____

*EP = EasyPump, ES = electric submersible, RF = RediFlo, BP = bladder pump, PB = Poly bailer

Attachment C. LLNL Baseline Sampling Data Sheet.